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SITE DEVELOPMENT FOR THE E. F. BARRETT POWER STATION

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POWER DIVISION

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SITE DEVELOPMENT FOR THE E. F. BARRETT POWER STATION

William Welch, Jr.[1]

The problems incident to the selection, acquisition and development of an entirely new major steam electric generating station site may become very complex, especially in a metropolitan area. The Long Island Lighting Company has just completed these stages in its program for the construction of the new Edward F. Barrett Power Station at Island Park, Long Island, New York. This plant, named in honor of the Chairman of the Board of the Company, is designed for a minimum ultimate capacity of 1,000,000 KW and may ultimately cost $150,000,000. The first unit, of the planned six, is now under construction. This report will comprise a brief description of the project to date and will fill in some of the background data leading to the many decisions made.

I. The Company and Its Problems

The Long Island Lighting Company supplies electric service to most of Nassau and Suffolk Counties, L.I., N.Y., and to that section of the City of New York known as the Rockaway Peninsula. The territory is approximately 110 miles long and varies in width to a maximum of about 20 miles at the center. The 1230 square miles of service area is the home of 1,400,000 persons comprising urban and suburban communities at the west end and large rural areas at the east. This results in approximately 80% of the population and load being concentrated in the westerly 30 miles of territory.

In 1940 the United States census showed that the territory served by Long Island Lighting Co. had a population of 650,000 persons. Statistics developed by this company indicate that the population has more than doubled in the 13 years since that census, and has increased 32% in the past three years. Not only have we been faced with this outstanding growth, but the increased availability of electric appliances has caused a corresponding increase in customer usage, so that the net result over the 13-year period has resulted in quadrupling our load.

In order to meet this demand our generating facilities were increased by the installation of two units in 1948 and 1950 providing a total of 110,000 KW of capacity in 1948 and 1950 at the new Port Jefferson site; two more units totalling 220,000 KW at a new plant adjoining the Glenwood Landing Plant in 1952 and 1954; and a 110,000 KW unit at a plant on a new site adjoining the Far Rockaway Plant. Figure I shows a map of the territory and the relationship of the new plant capacity to the area served.

However, continued growth and the revised load forecasts soon made it evident that the program outlined above would be inadequate to supply the load expected for the winter of 1956. In 1952, therefore, the decision was

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reached to plan for further increase of plant capacity. It did not appear judicious to increase plant capacity at existing sites at this time—site restrictions hampered further development of Glenwood, Port Jefferson was too remote from the area of growth, and the location at Far Rockaway could not be utilized without further extensive development of cooling water facilities. We were, therefore, faced with the task of locating a completely new plant site.

II. Requirements of a Good Power Plant Site

The evaluation of a power plant site is largely dependent on the following requirements which, in the ideal site, should be satisfied.

1) The site must be reasonably close to the load center to minimize transmission costs and transmission losses.
2) Zoning restrictions in the area must permit construction for this type of operation.
3) The site must be large enough to permit development to the ultimate capacity required. Preliminary studies indicated this would be 1,000,000 KW requiring the purchase of property of not less than 100 acres, and preferably larger.
4) Transportation facilities, both rail and water, must be available for delivery of operating supplies as well as the delivery of equipment and materials during construction. As none of the present plant sites had direct rail connection it was considered advisable to provide such facility for a new station.
5) The site must have access to large quantities of cooling water.
6) Adequate means of egress for the high voltage transmission lines must be available.

In addition to the foregoing there are certain other requirements, of somewhat lesser importance, but which nevertheless must be considered. There should be favorable terrain and sub-surface conditions; the location should be reasonably close to the labor market and at the same time relatively remote from residential areas and fresh water must be available in adequate quantities. It is recognized that very rarely are all of the foregoing requirements satisfied and that the final selection involves a compromise of several of them.

III. Selection of the Site

The initial step in the selection of the site involved a detailed investigation of existing maps for possible sites along the north shore (Long Island Sound) and along the south shore (Atlantic Ocean and bays). This research was supplemented by extensive field trips in which local surrounding conditions were very carefully observed and noted. Following this initial step which eliminated a large number of possible sites we utilized a new and what proved to be a very potent source of information namely aerial photographs. The entire territory of the Long Island Lighting Co. had been photographed by aerial survey a year or two prior in connection with the preparation of a mapping program, for transmission and distribution facilities. It was the exhaustive examination of these photographs that pin-pointed the area in which we were to finally locate. Figure II shows the site selected in aerial view.

This area which is close to the center of our load growth comprises marsh

land located about 2 miles north of the Atlantic Ocean and lying between two dredged channels. Not only would we be given access to the ocean for adequate cooling water by these channels and other connecting small bodies of water but it became evident that we could by dredging provide adequate water transportation to the potential site. Furthermore, a branch of the Long Island Rail Road line extending through the site assured adequate rail facilities.

Although field investigation, backed by our knowledge of local conditions, showed that while the land surface was meadow bog and mud flats, our knowledge of the area indicated that good sand and gravel probably could be found about 10-15 feet below the surface. We also knew from previous experience that good sand and gravel were available in the nearby channels which by dredging could be used for hydraulic fill. Our studies, our investigations, the maps we used, and all other information which became available to us showed that this site was well suited for the construction of a power station.

IV. Acquisition of the Site

Ownership studies indicated that the property was held in many hands. A large portion, that adjoining the main highway to a resort city, had been laid out in small parcels on mapped streets by a real estate development corporation which ultimately foundered; consequently, ownership was found to be very widespread. Certain other parcels had been acquired by venture capital and likewise were held under several ownerships. However, the key piece of some 58 acres including a large area of land underwater was held by the Town of Hempstead under a Colonial Grant.

The speed with which this site was assembled under the guidance of the Company's Legal Department is noteworthy and deserves mention at this time. The choice of the site and decision to proceed was made early in 1952. A proposition to purchase the land from the Town of Hempstead was made in August, 1952 and after an independent appraisal, and a referendum by the voters of the Town were completed, title to the property was taken on January 3, 1953. Complete and clear titles were obtained on most of the small parcels by November 1, 1952 and a large privately owned parcel was finally cleared by mutual settlement in April, 1953 after condemnation suit had been instituted. Application to rezone the property for plant construction was granted on May 26, 1953. In other words, a period of only 17 months elapsed from the time of the decision to use this site until the land had been assembled and proper permits had been acquired for its use as a power plant area.

Also noteworthy was the acceptance by the voters of the proposal to sell Town-owned lands for the purpose of building the power station. The vote resulted in 111,590 for the sale and 10,689 against or a favorable ratio of 11 to 1.

V. Site Development and General Plant Arrangement

Figure III shows the property when acquired. Generally the area consisted largely of salt marshes with some mud flats and about 20% of land underwater. A small section (the former real estate development area) had been brought to grade by hydraulic fill some twenty years prior to our acquisition.

Hog Island Channel, on the westerly side of the property, had already been deepened and developed for use by tankers to deliver oil to several tank farms north of our property. It was logical, therefore, to locate the future docking facilities for water borne coal and fuel oil as well as fuel storage facilities on the 27 acres west of the railroad tracks. It was decided that the circulating water intake would be made from this channel and that the discharge would go into the easterly waterway known as Barnum's Island Channel. This layout will require deepening of the intake channel to assure an adequate supply of cooling water and at the same time necessitates the strengthening of the railroad bridge. A discharge canal will be constructed so that the warm water will flow under the highway bridge. This will necessitate some dredging of Barnum's Island Channel. A study shows that the water route distance from the discharge to the inlet through the various connecting waterways is about 4 miles. This distance plus normal tidal action eliminates the possibility of any recirculation of condenser water.

The tracks of the Long Beach Branch of the Long Island Rail Road divide the site into two parcels. The parcel to the west of the tracks along Hog Island Channel and consisting of approximately 27 acres was the logical place for the coal storage area. The larger parcel on the east side of the tracks will be reserved for the main plant site, substation, service building and railroad unloading facilities.

Concurrent studies indicated that the plant should be designed for an ultimate of 6 units eventually totalling at least 1,000,000 KW in capacity; that each unit should be of the single boiler, turbine generator, step-up transformer type and that the first of these units should be of 170,000 KW rated capacity, designed for steam conditions at the turbine of 1800 psig, 1000°F with the steam being reheated to 1000°F, after passing through a portion of the turbine.

Operating and design experience at the plants installed during the last five years indicated the advisability of continuing the company policy of installing modified outdoor type plants. Since there was adequate ground area and because of subsurface conditions the plant was spread out horizontally with a lower operating level at grade. We might borrow from the architectural language of the day and apply the general description "Ranch Type" to this particular design.

Figure IV shows the final plant arrangement. The generating units will be oriented generally north and south with the stacks to the south and the generator step-up transformers on the north side. The switchyard and substation areas will be beyond the circulating water intake and discharge canals. The coal car thaw sheds and car dumping pits have been located on the easterly side of the railroad with ladder storage tracks for full and empty coal cars paralleling the southerly property line. Coal from the unloading pits will be elevated by belt conveyor to a junction tower and from that point will be transported either to the coal silos in the plant or to the coal storage area by means of a conveyor bridge crossing the railroad. Reclaimed coal from the pile will be handled by a tunnel conveyor under the railroad to an elevating conveyor at the car dump pit. At present, plans call for only railroad delivery of coal for the first unit to be installed. However, the plans do provide for the eventual construction of a bulkhead and coal unloading tower for water borne fuel in the future.

The construction areas, service building, parking lots, etc., will be located southerly, adjacent to and with direct access to the main highway known as Long Beach Road. Switchyards and substations, both transmission and local

distribution stations, are located at the northerly portion of the property. Transmission line exits from the property will go north along the highway and the railroad right-of-way. Transmission lines for the first unit will be 138 kv underground cable of the high pressure oil type.

VI. Soil Conditions

The entire portion of the purchased site west of the railroad was marshy and low enough to be flooded whenever wind and tide conditions combined to make the tide higher than normal. On the easterly side of the railroad an estimated 15 acres showed ground above the 6 ft. contour. The remainder of the area was subject to complete flooding. In the extremely low lying portions on both sides of the railroad, drainage ditches had been dug to drain the areas which were filled with water at normal high tide.

In order to prepare such land for the construction of a power plant it was necessary to conduct extensive sub-surface investigations. A recognized consultant was engaged to make a complete analysis. Borings were made at 29 locations varying in depth up to 130 ft. but averaging about 50 ft. In all cases rotary drilling methods were used with the holes being kept open with drilling mud instead of casing. The nature of the soils present was determined by means of samples obtained using a thin wall 3 inch (Shelby tube) core barrel. In sampling clays the core billet was forced down by hydraulic pressure from the drilling rig, in those locations which were accessible to a rig. In sands the core billet was driven by blows of a 140 lb. hammer with a 30 inch drop. In the locations which could not be reached by the drilling rig the sampler was forced into the soft surface soils by hand (or by the weight of the sampler and drill stem) and into the deeper clays by driving as in the sand. Clay samples were preserved in an undisturbed state for laboratory testing in order to determine soil properties and possible clues as to bearing capacity.

The Consultant's report showed that the surface deposit was composed of a mixture of highly compressible organic silt varying in thickness from 12-14 ft, except in that area which had previously been filled, where the organic silt measured only 6 ft. Below this surface deposit was found a stratum of loose to firm clean sand with an average thickness of 10-15 ft. Below this sand there was a deposit grading from a silty fine sand at the top to a varved silt and fine sand near the middle, then back to a silty fine sand near the bottom. This layer with an average thickness of 10 ft. did not appear in the northern portion of the site.

Under the silty sand was found a deposit of clean dense course to fine sand about 15-25 ft. in thickness. This was followed at elevation -50 to elevation -110 by alternate layers of course to find sand and a stiff dark grey silty clay. These strata were not uniform in thickness across the area but the combined thickness of the clay stratum and its underlying sand deposit was constant throughout. Below this depth there was dense fine sand deposit to an undetermined thickness. These formations are indicated in Figure V.

VII. Settlement

The final grade in the plant area will be at Elevation 11 with the first floor of the station being at Elevation 12. Because the existing average grade at the site was approximately 4 feet above mean low water, it was necessary to add fill.

Our soil studies indicated that under the loading imposed by the fill required to bring the plant area to the desired elevation the highly compressible top stratum of root mat and bog mud would probably settle as much as 1-3 feet depending upon the composition of the bog. In order to accomplish as much consolidation as possible prior to actual construction approximately 500,000 cubic yards of fill were dredged hydraulically and placed during the spring and summer of 1953. The fill was a mixture of sand and gravel of excellent quality and was obtained from the beds of adjacent waterways and bays.

Generally the fill was brought to Elevation 13 to impose additional loading and to attain the desired final elevation after settlement.

For the varying soil conditions we could only approximate the time rate of settlement inasmuch as the coefficient of consolidation at any one point would vary greatly from that at any other location. It was estimated that about 50% of the ultimate settlement should be completed in two years, 80% in ten years and the remainder in the order of 1/4 inch per year. In the coal storage area west of the railroad tracks, settlement will be accelerated by the added load imposed by approximately 30 ft. of coal.

Not all of the site was filled. To minimize costs and to provide for disposal of the fly ash produced as a by-product of our operations that portion of the site not to be used immediately for construction purposes was reserved for future filling by plant ash.

VIII. Pre-consolidation at Construction Area

Investigation prior to the start of construction showed that consolidation of the meadow mat has not progressed sufficiently to permit excavation without restraining sheet piling. To accelerate pre-consolidation and obtain a dry stable working area without resorting to sheathing, a well point system whose risers extend through the meadow mat into the underlying sand will be installed. By pumping a 23-inch vacuum in these risers a surface load, including the 775 pounds per square foot of perched water and fill, of 2900 pounds per square foot will be imposed on the stratum of meadow mat. This system will be installed to completely surround the area of the foundations and will operate continuously for a period of two weeks, and should expedite the consolidation processes to such a degree that settlement which would normally require 5-10 years will be achieved in a few months. After the meadow bog has been collapsed, conventional sand drains will be punched through the fill area and the bog to the well points in order that the area might be de-watered in the conventional manner.

This pre-consolidation system is being used also in the areas immediately adjacent to the plant so as to eliminate adverse effects upon structures. However, such areas as roadways, parking and storage fields and railroad tracks will be allowed to settle naturally. Consequently, certain amounts of fill and regrading will be necessary over the years.

IX. Substructures and Foundations

It was evident from the soil investigations that no concentrated load of any magnitude could be placed directly on the earth. Consequently, all structures will be supported on piling. Contrary to our practices at Glenwood Landing and Far Rockaway, where a single concrete mat 5 ft. thick was poured over the entire plant area to serve as a platform for the construction, the Barrett

Plant substructures will consist of individual footings connected by a light slab. Our studies showed this construction to be entirely satisfactory and economical. Several types were considered, namely, wood piles, cast-in-place concrete and steel shell piles and the pedestal type. Because of the relatively poor character of the sub-surface soil it was decided that heavy load concentrations might be undesirable and consequently the pedestal pile was ruled out. Creosoted wood piles were finally chosen over the cast-in-place piles because of the low cost, better load distribution and adequate high ground water conditions.

Test boring studies indicated that effective bearing could be had if the piles were driven into the stratum of fine and coarse sand about 50 ft. below the finished surface. In view of this, all piles under the plant structure will average 50 ft. in length. Shorter piles will be used for auxiliary structures where the loads are not as heavy.

As a matter of precaution it was decided to support all permanent or critical installations on piles. Where possible, electric conduit and yard piping will be grouped and supported on pile bents. Similarly in the substation area all structures including those with light loads are supported on piles. For instance, electrical bus work between sections is carried on posts which are supported by piling. Obviously the porcelain bus support insulators must be maintained in strict alignment and settlement of the degree expected cannot be tolerated.

X. Surface Soil Stabilization

Although the sand fill is of good quality it does contain a relatively large percentage of fine particles. There has been some drifting of loose sand during periods of high winds. Several methods of control are being considered. The cultivation of beach grass which grows in barren sand has been ruled out because a proper cover would be extremely difficult to maintain during the construction period. At the present time small experimental areas are being developed in order to determine the proper soil mixtures to sustain less sensitive permanent growth. Various combinations of sand, fly ash and organic bay muck together with small percentages of lime are being spread over these areas. After a short leaching period, several types of grasses indigenous to salt water regions will be planted and after observation the type best suited to the local conditions selected for ultimate landscaping and soil stabilization.

Fly ash, which results from the combustion of pulverized fuel, is being considered as a method of sand stabilization. Tests have indicated that fly ash mixed into the upper 3 or 4 inches of sand in the proportions of 35-50% of fly ash proved an effective method for the consolidation of loose beach sand.

XI. Use of Ash

The problem of ash removal has become a serious matter in most coal burning plant areas. Possible practical uses for fly ash are being investigated continually by the Long Island Lighting Company. At Barrett Station we have employed fly ash as a substitute for 25% of the rock screenings used as filler material for the temporary roads and parking fields. It will be used as a replacement for all of the mineral filler in the asphaltic concrete topping for the future permanent paving. In addition, fly ash will

replace not more than 20% of the cement used in the mass concrete for certain selected substructures and foundations.

XII. Conclusion

At the time of this writing, in the latter part of 1954, construction of foundations for the new E. F. Barrett Plant is about to start. Many man-hours of investigation and study have been used since the first decision to build was made in the latter part of 1951 and the brief outline of some of the problems which have been given above, we hope, will emphasize the fact that the modern public utility spends a great deal of time and energy in exploratory and pre-engineering work. Our experience with the development of an appropriate site for the E. F. Barrett Plant brings home again the fact that the public which must be served adequately with electricity, must likewise be served with intelligent planning and in the spirit of community effort.

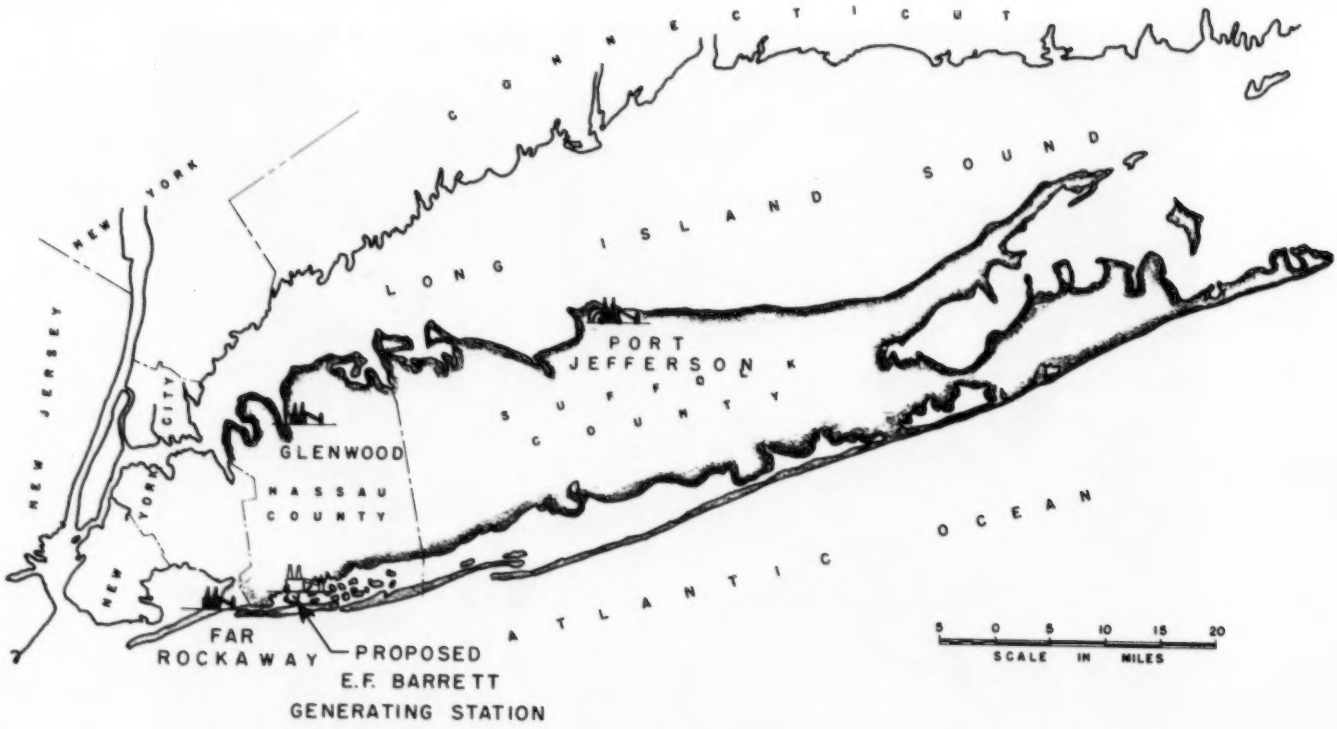


Fig. I. Territory of the Long Island Lighting Company.

Fig. II. Aerial View of Proposed Plant Site.

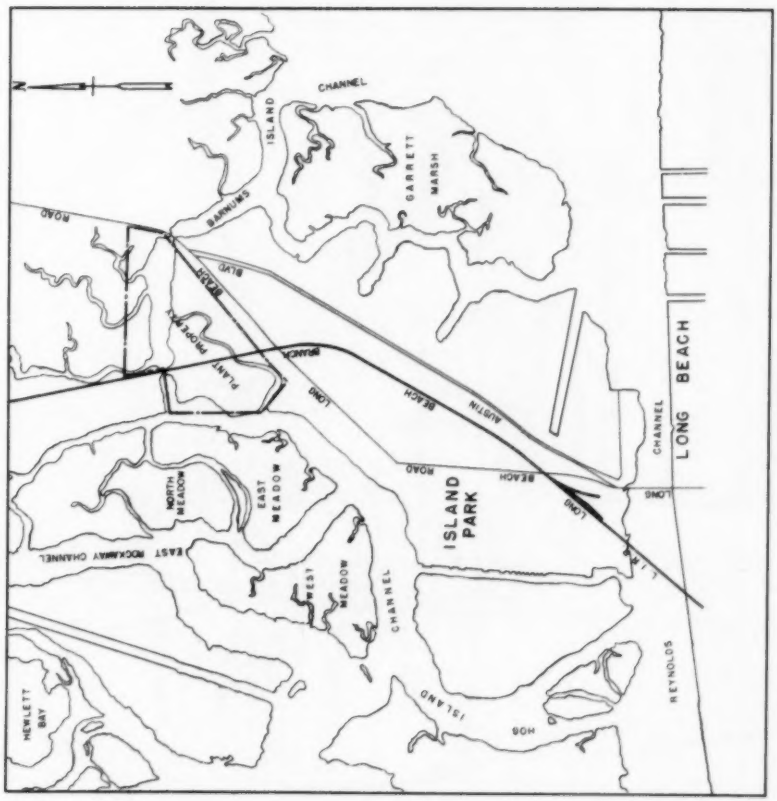


Fig. III. Plant Property and its Relation to Surrounding Territory.

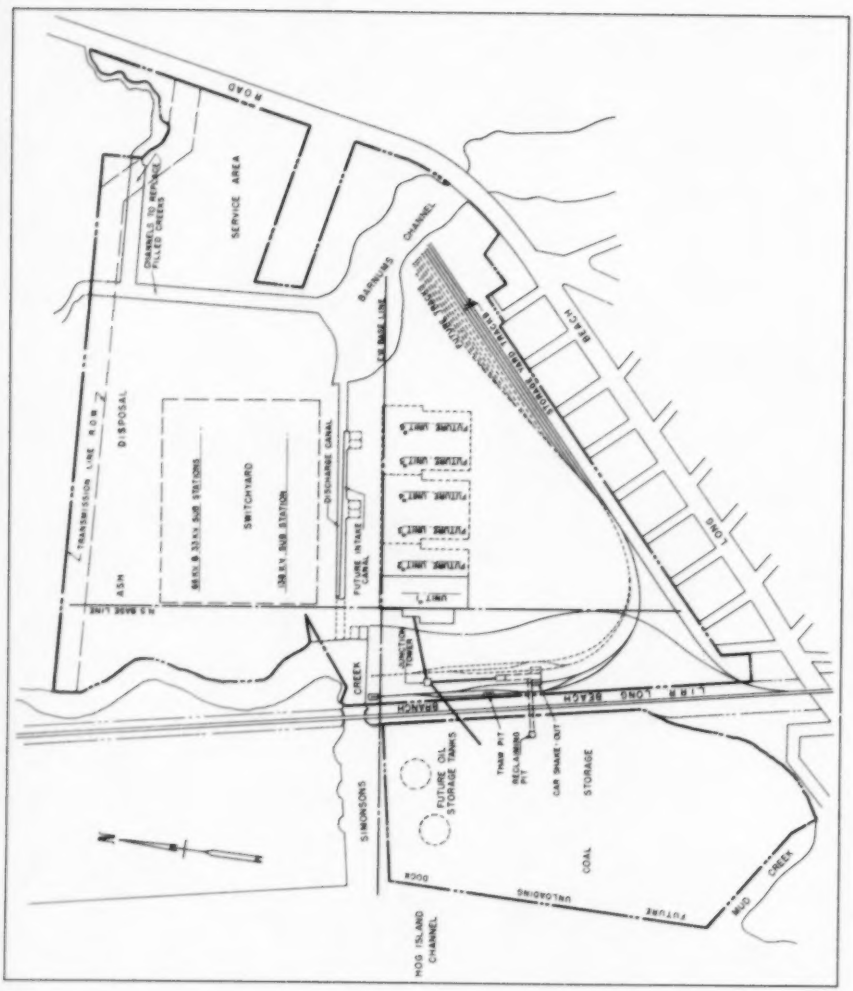
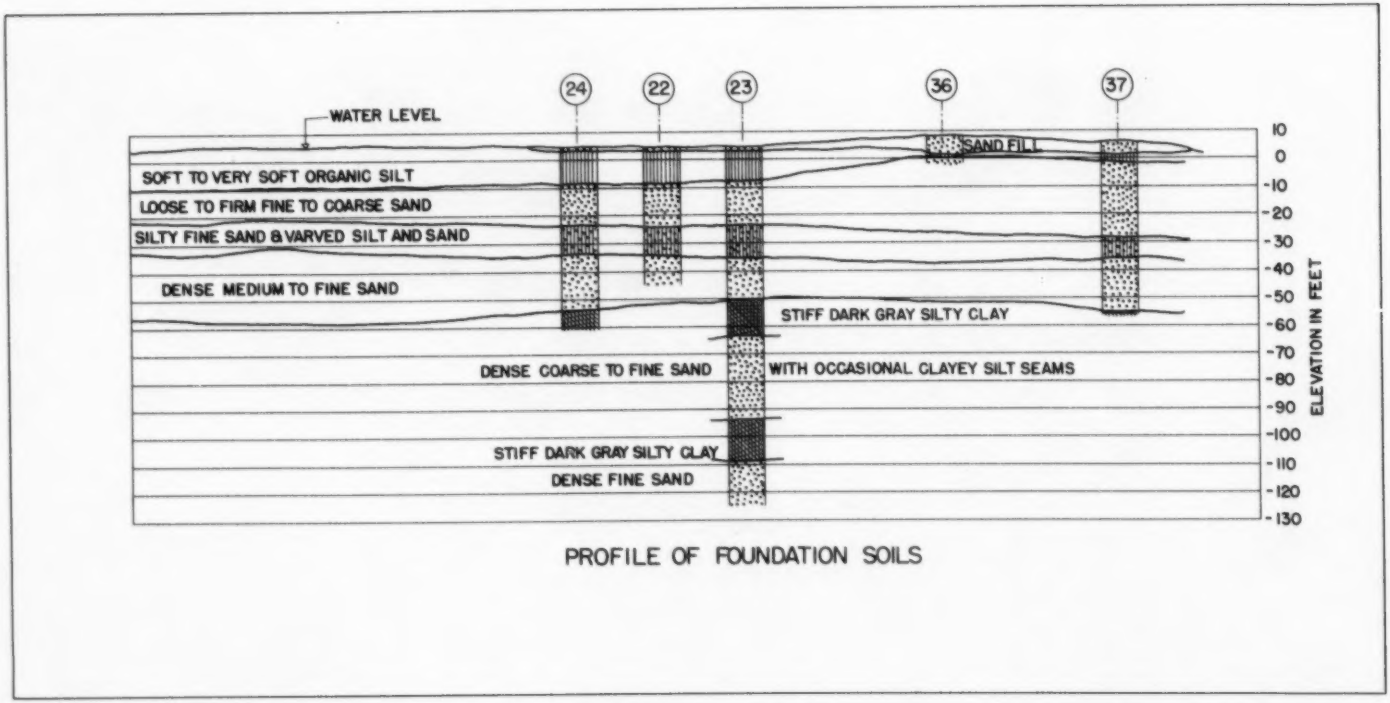


Fig. IV. Plant Arrangement.



PROFILE OF FOUNDATION SOILS

Fig. V.

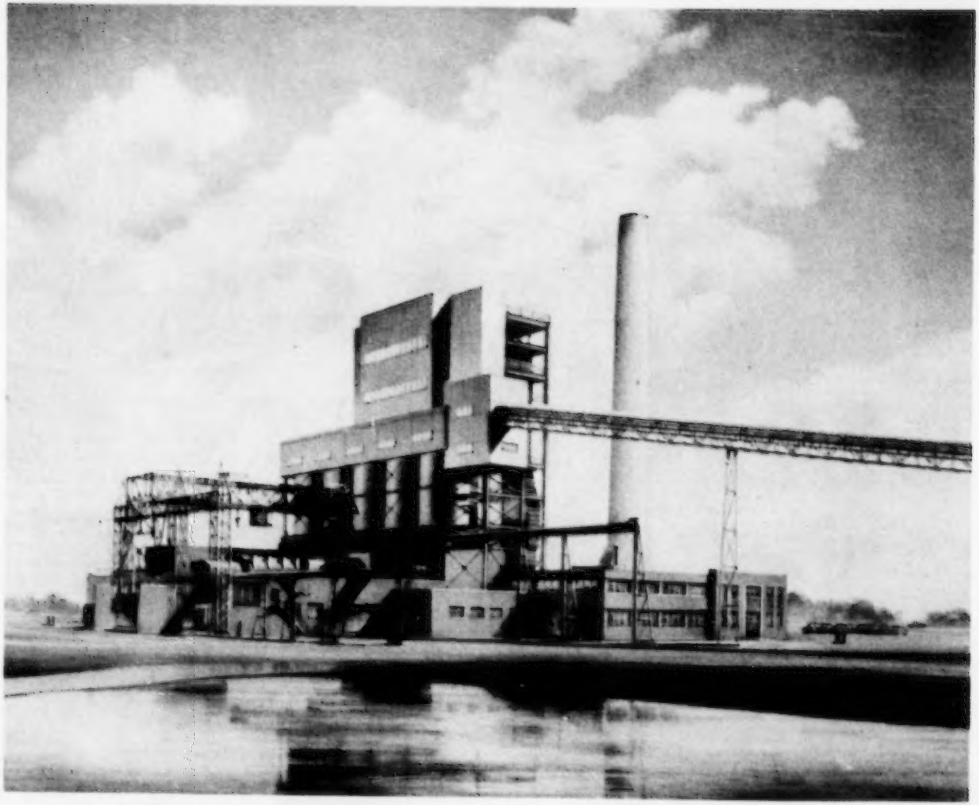


Fig. VI. Architect's View of E. F. Barrett Plant.